NEXT: A new Neutrino-less Double Beta Decay Experiment

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What is *NEXT* ?

NEXT stands for ***N***eutrino ***E***xperiment with ***X***enon ***T***PC

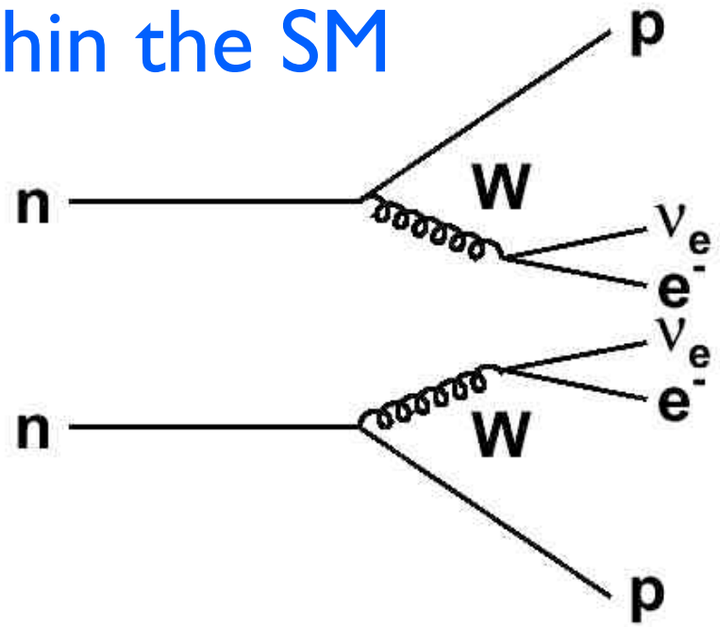
Due to a positive decision of the Spanish Ministry of Science the newly founded NEXT collaboration has approved to establish a 100 kg ^{136}Xenon high pressure TPC in the new Underground Laboratory in Canfranc.

Scientific Program has to clarify:

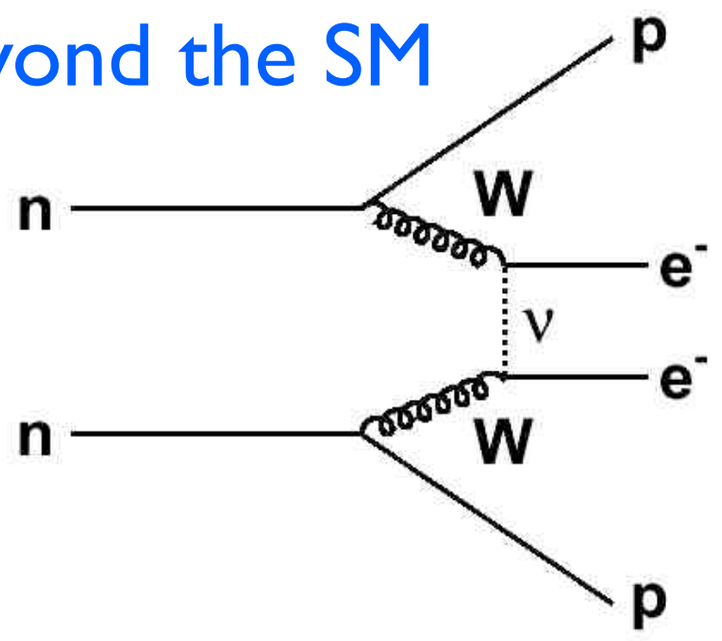
- How to build a detector for $\beta\beta^{0\nu}$ (and WIMP) searches in five years from now ?
- How could such a 100 kg high pressure TPC look like ?

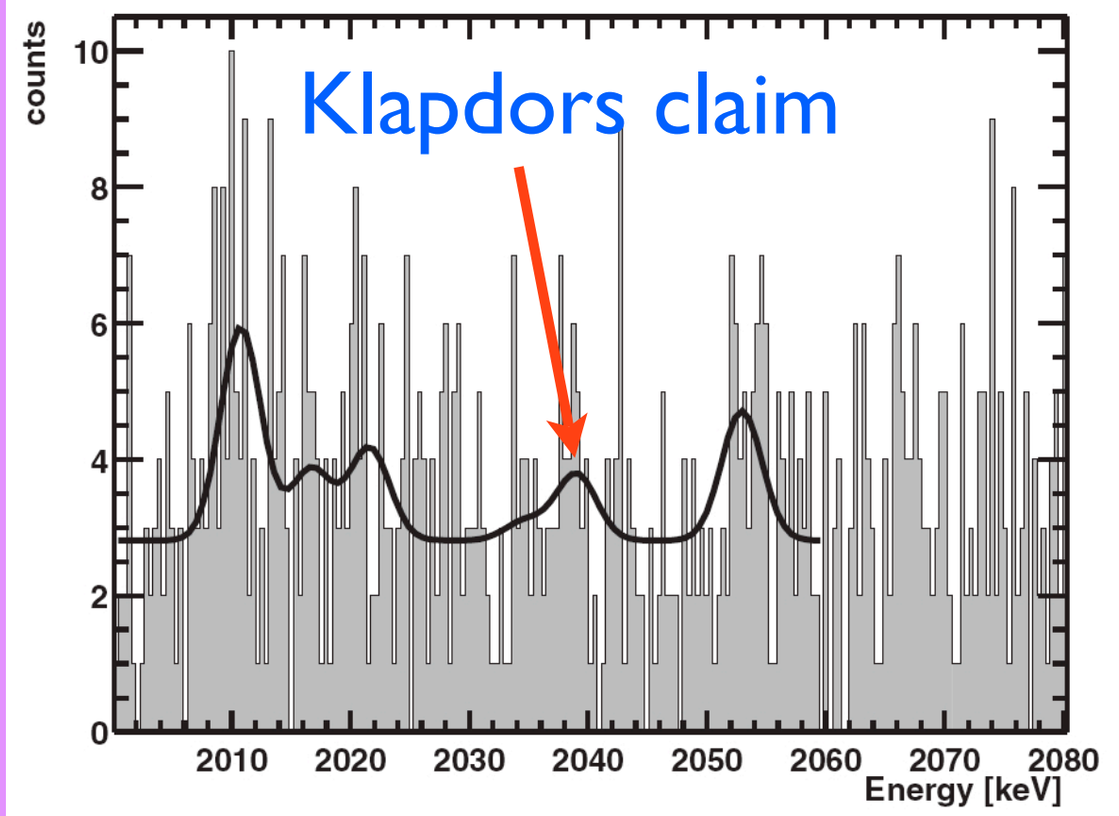
What makes $\beta\beta^{0\nu}$ so exciting today ?

within the SM



beyond the SM





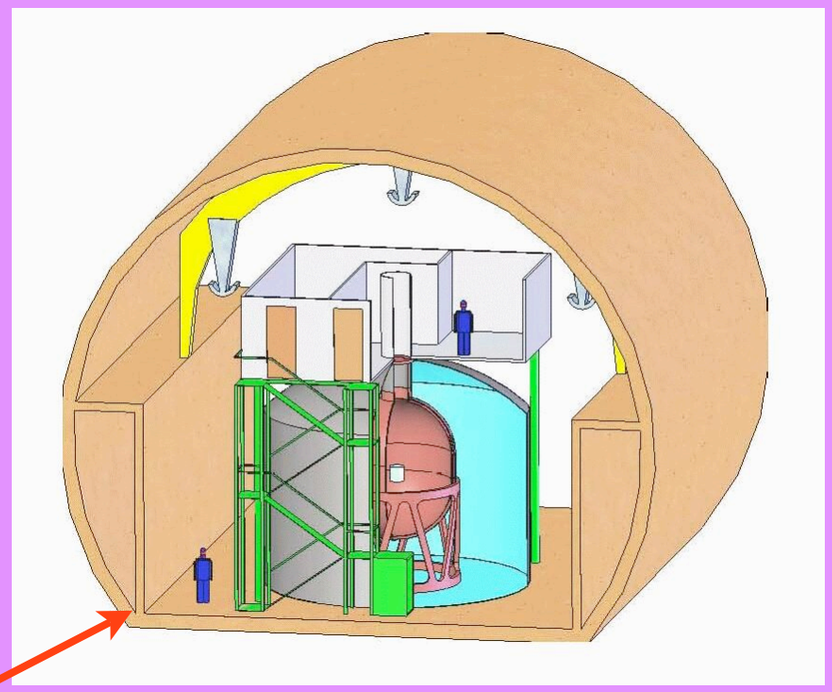
One way to prove Klapdors claim:
Reject or verify it with experiments

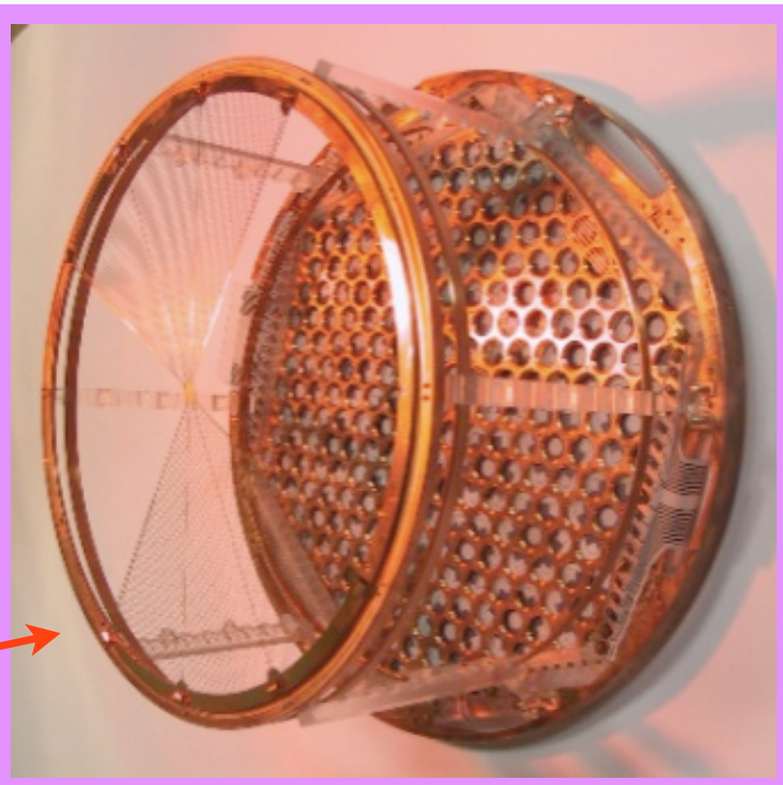
- higher mass of $\beta\beta$-isotope
- better background rejection
- verify for more than one isotope

Future experiments for $\beta\beta^{0\nu}$

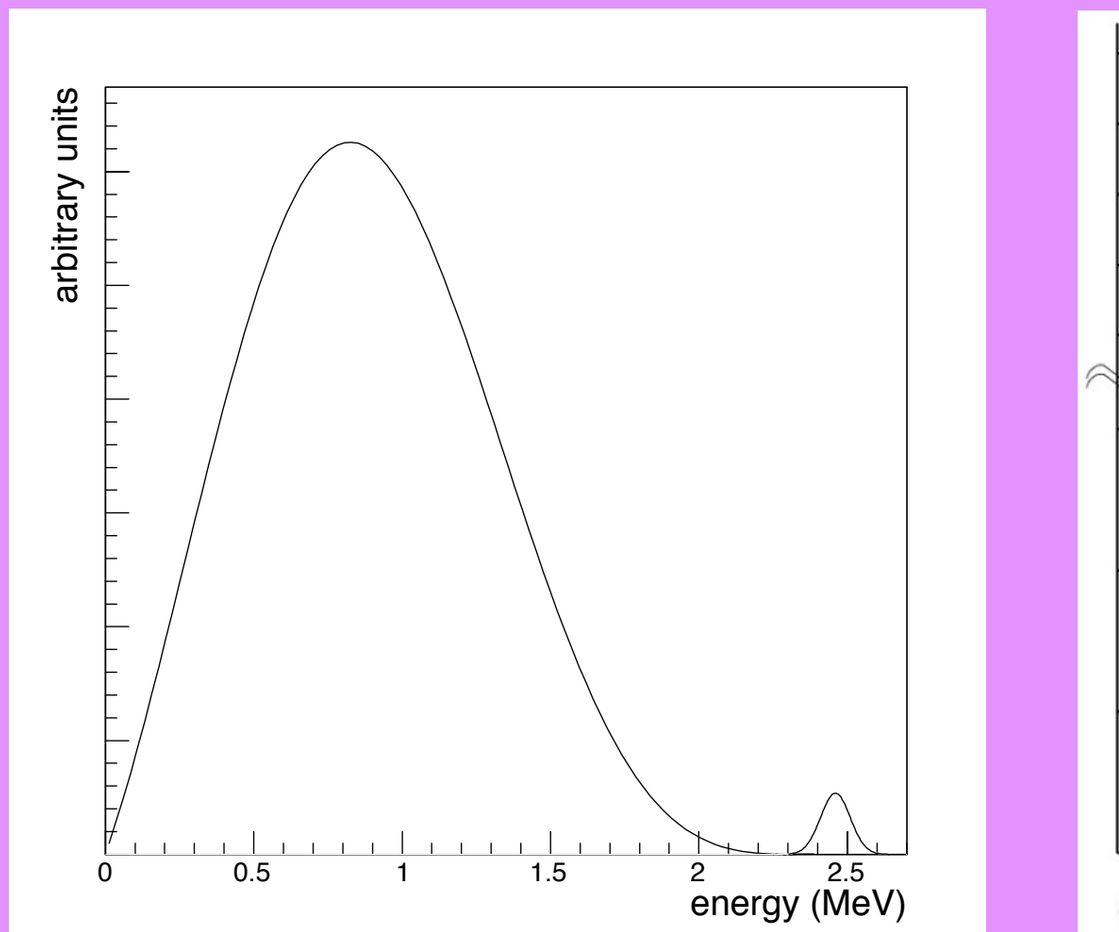
Isotope	$Q_{\beta\beta}$ (keV)	i.a. (%)	$T^{2\nu}_{1/2}$ (y)	FN (10^{-24} meV$^{-1}\cdot$y^{-1})
^{48}Ca	4271 ± 4	0.187	$(4.2 \pm 1.2) \times 10^{19}$	
^{76}Ge	2039.6 ± 0.9	7.8	$(1.3 \pm 0.1) \times 10^{21}$	0.4
^{82}Se	2995 ± 6	9.2	$(9.2 \pm 1.0) \times 10^{19}$	1.3
^{100}Mo	3034 ± 6	9.6	$(8.0 \pm 0.6) \times 10^{18}$	1.4
^{116}Cd	2802 ± 4	7.5	$(3.2 \pm 0.3) \times 10^{19}$	1.1
^{130}Te	2528.8 ± 4	33.8	$(2.7 \pm 0.1) \times 10^{21}$	1.4
^{136}Xe	2479 ± 8	8.9	$> 8.1 \times 10^{20}$ (90% CL)	0.8
^{150}Nd	3367.1 ± 2.2	5.6	$(7.0^{+11.8}_{-0.3}) \times 10^{18}$	13.8

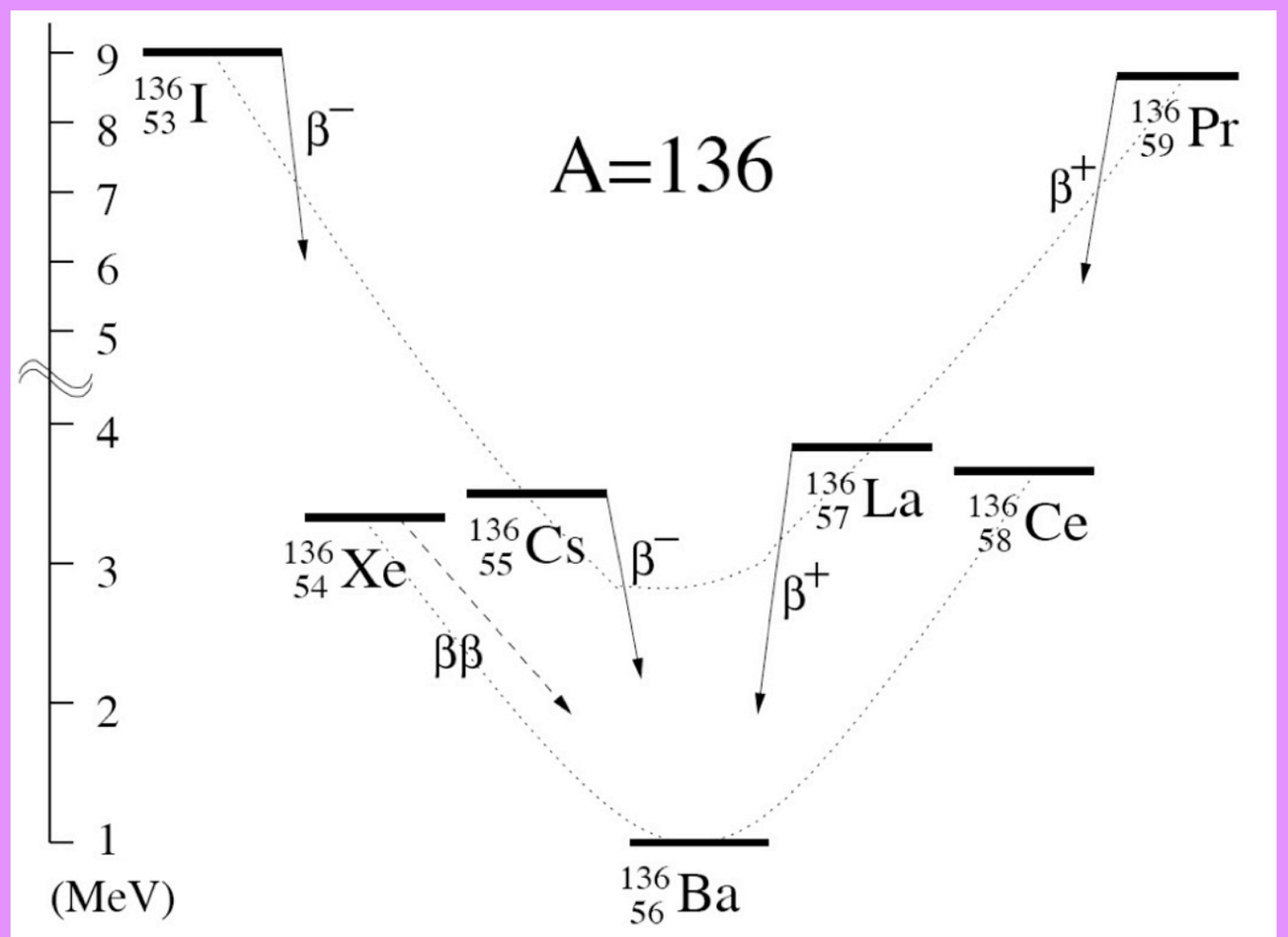
Experiment	Isotope	i.a. (%)	Mass (kg)	Technique
GERDA	^{76}Ge	86	40	Ge diodes in liq. scint.
MAJORANA	^{76}Ge	86	120	Ge diodes
COBRA	^{116}Cd	nat.	418	CZT semiconductor
CUORE	^{130}Te	nat.	741	TeO_2 bolometers
CANDLES	^{48}Ca	nat.	tons	CaF_2 scint.
CAMEO	^{116}Cd	83	tons	$CdWO_4$ scint.
SNO+	^{150}Nd	nat.	500	Nd salt in liquid scint.
SuperNEMO	^{82}Se (^{150}Nd)	90 (?)	100	Foils in tracko-calo
EXO-200	^{136}Xe	80	200	LXe TPC





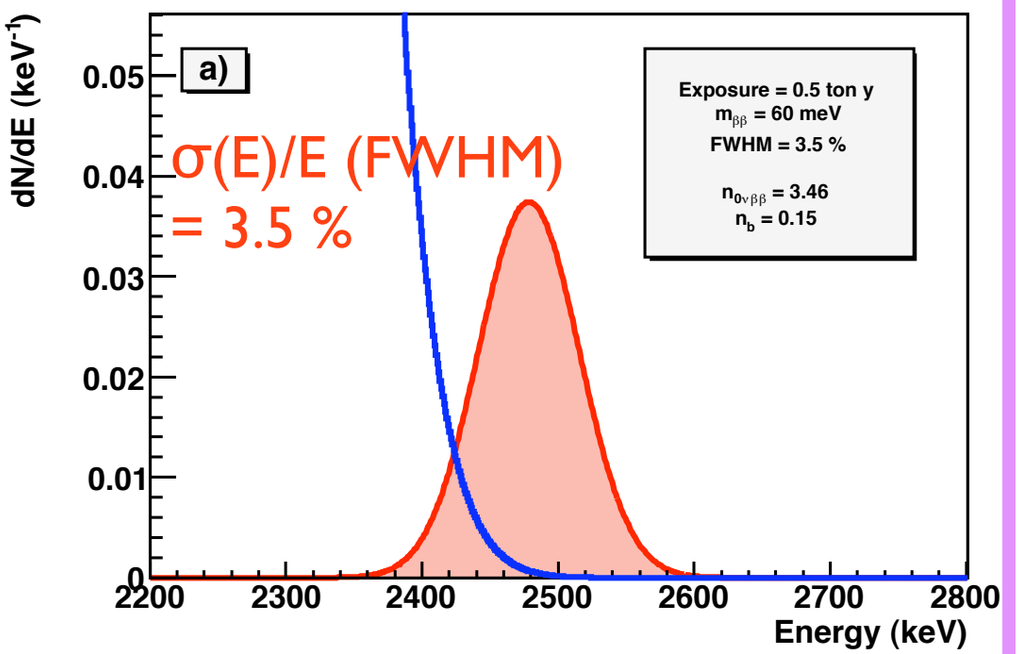
What makes ^{136}Xenon attractive ?

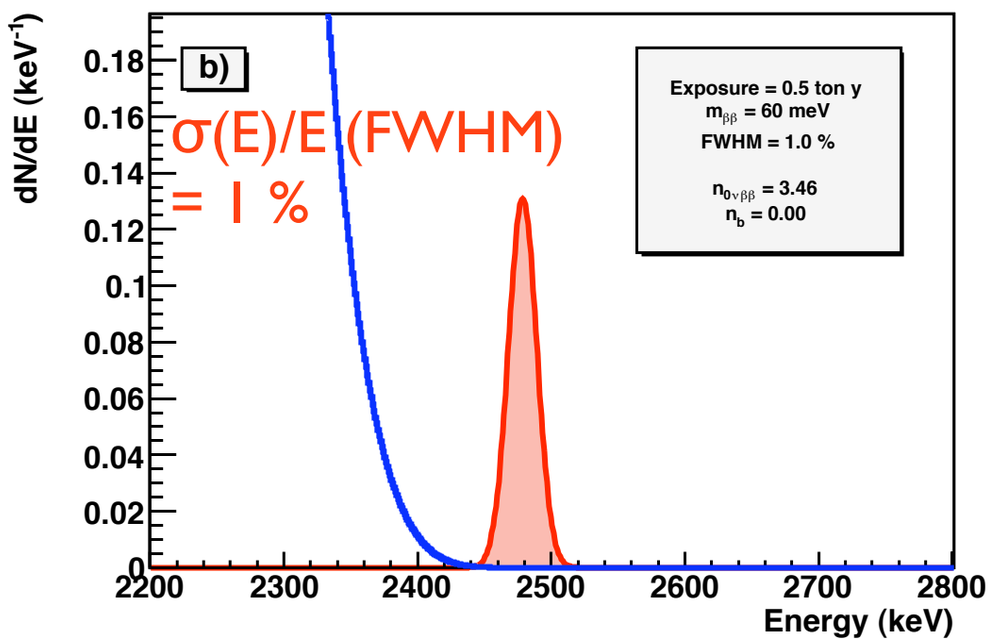


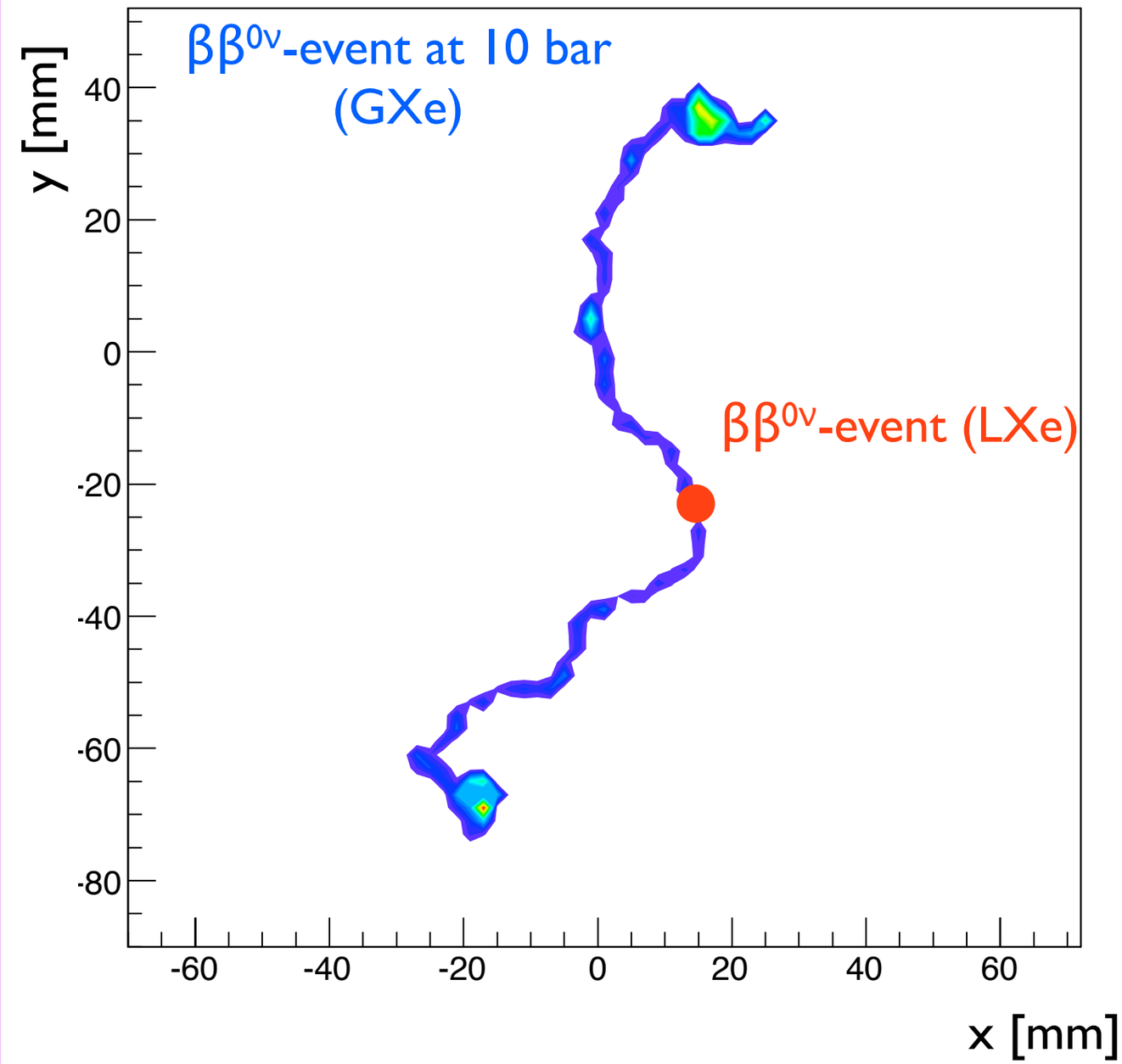


- ^{136}Xe is 10 % in natural Xe, could be "easily" enriched.
- ^{136}Xe has no other isotopes with long life time.
- It is scalable to high masses (100 kg - 1 ton)
- Liquid TPC key advantage is the compactness of the detector
- Gaseous TPC provides additional handle for BG (pattern recognition)
- Has also a potential for WIMP searches (see D. Nygrens talk).

The Event Topology of a HP-Xenon TPC



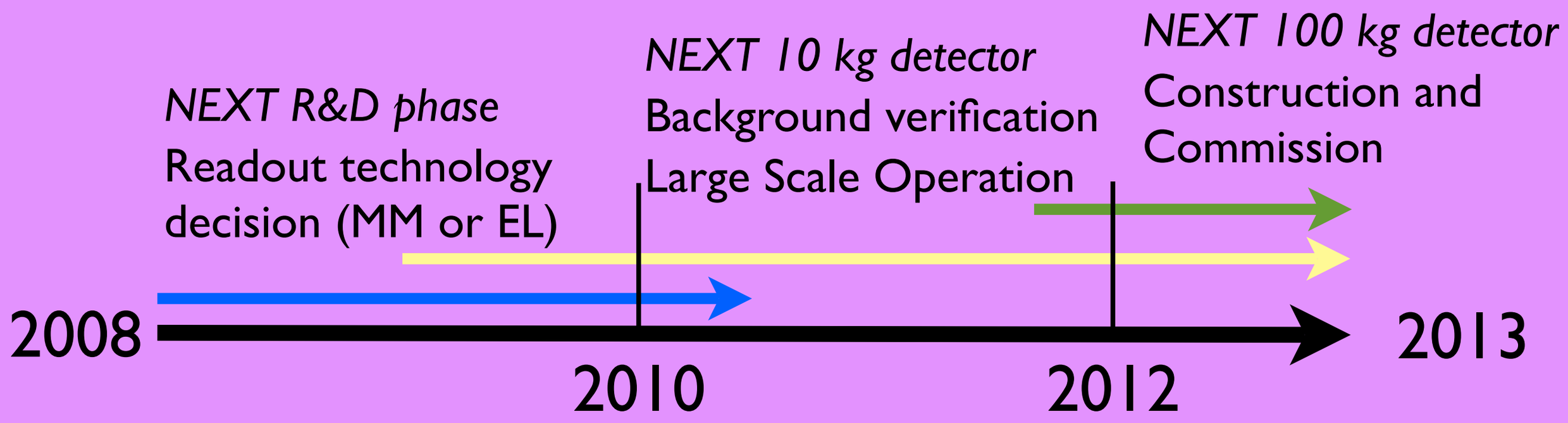




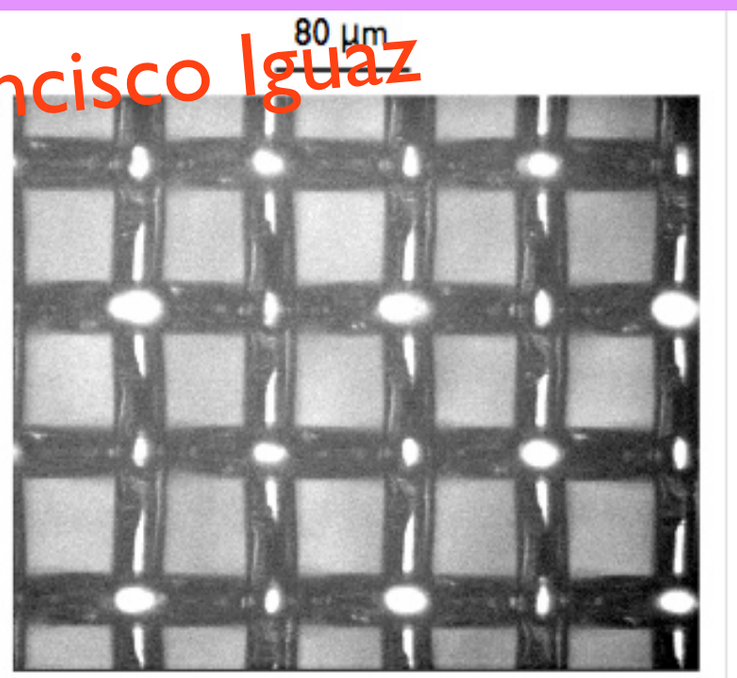
Who is *NEXT* and what is our roadmap ?

- IFAE Barcelona,
- U. de Gerona,
- CIEMAT Madrid
- U. de Santiago de Compostela,
- IFIC Valencia,
- U. Politécnica de Valencia,
- U. de Zaragoza

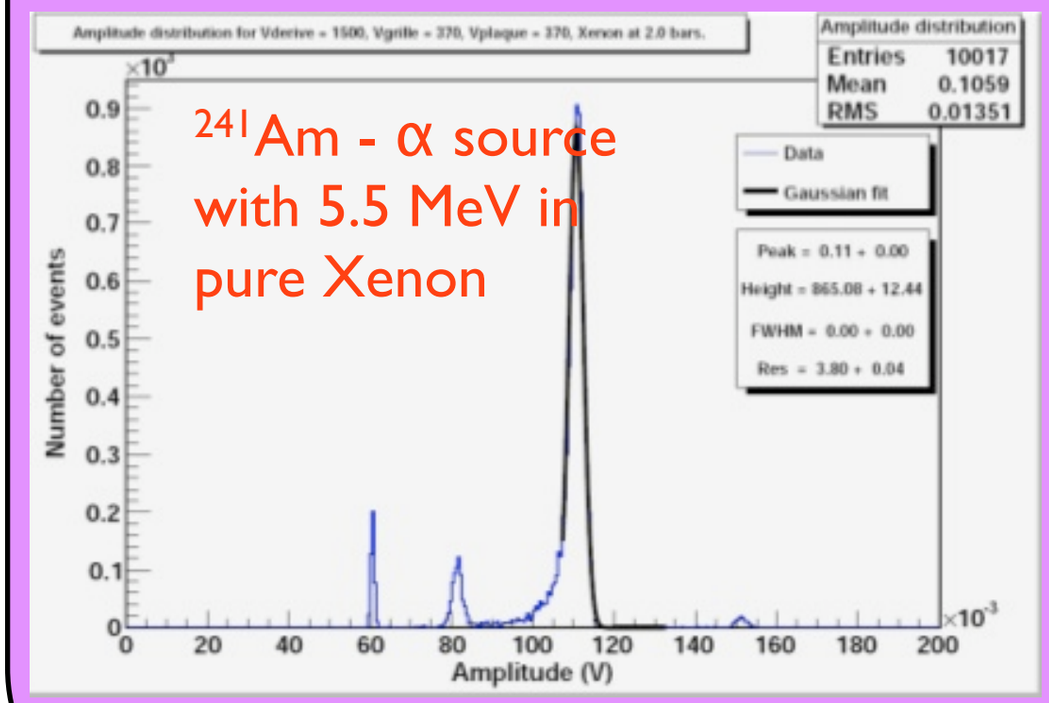
International Advisors:
Dr. D. Nygren (LBL),
Dr. A. Bernstein (Livermore),
Drs. I. Giomataris & E. Ferrer-Ribas (Saclay)
Dr. E. Radicchio (U. Bari)
Prof. A. Bettini (LSC)



MM operation in HP-Xenon



- First Measurement in pure Xenon for 2, 3 and 4 bar.
- Attachment effects were observed due to imperfection of the closed gas system.
- E_{res} given for attachm. and no attachm.



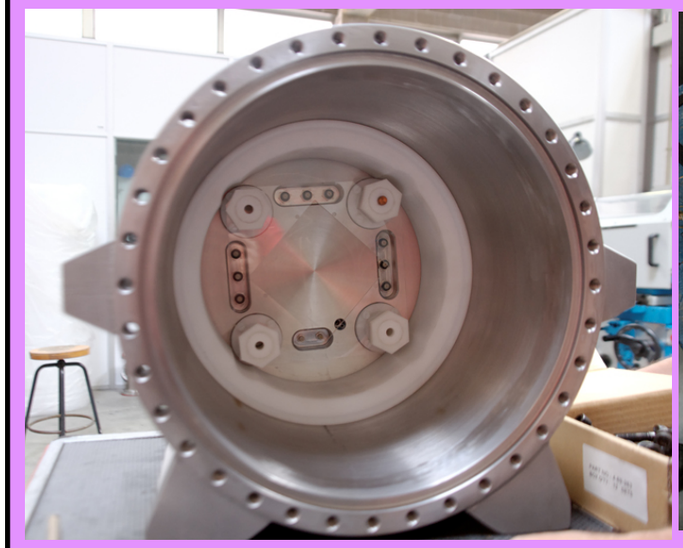
^{241}Am - α source with 5.5 MeV in pure Xenon

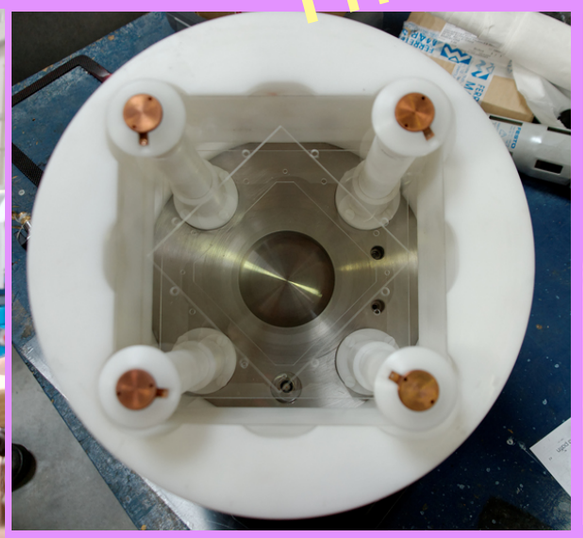
Preliminary

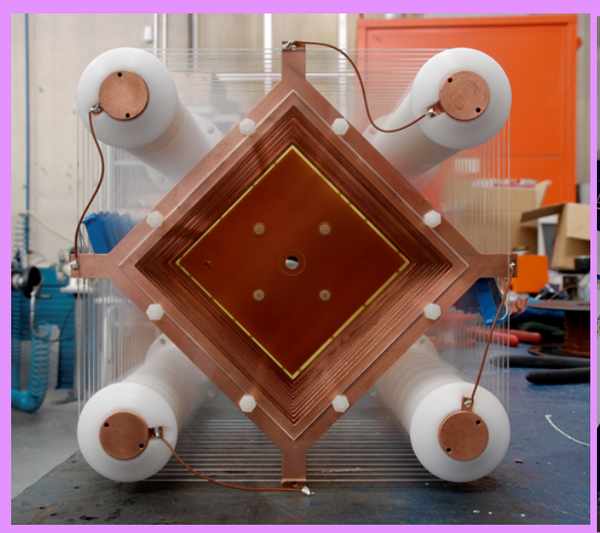
Pressure [atm]	E_{res} (FWHM) [%]	E_{res} (FWHM) [%]
2	3.8	2.8
3	7.5	4.9
4	10.3	4.5

?

HP-TPC prototype for EL



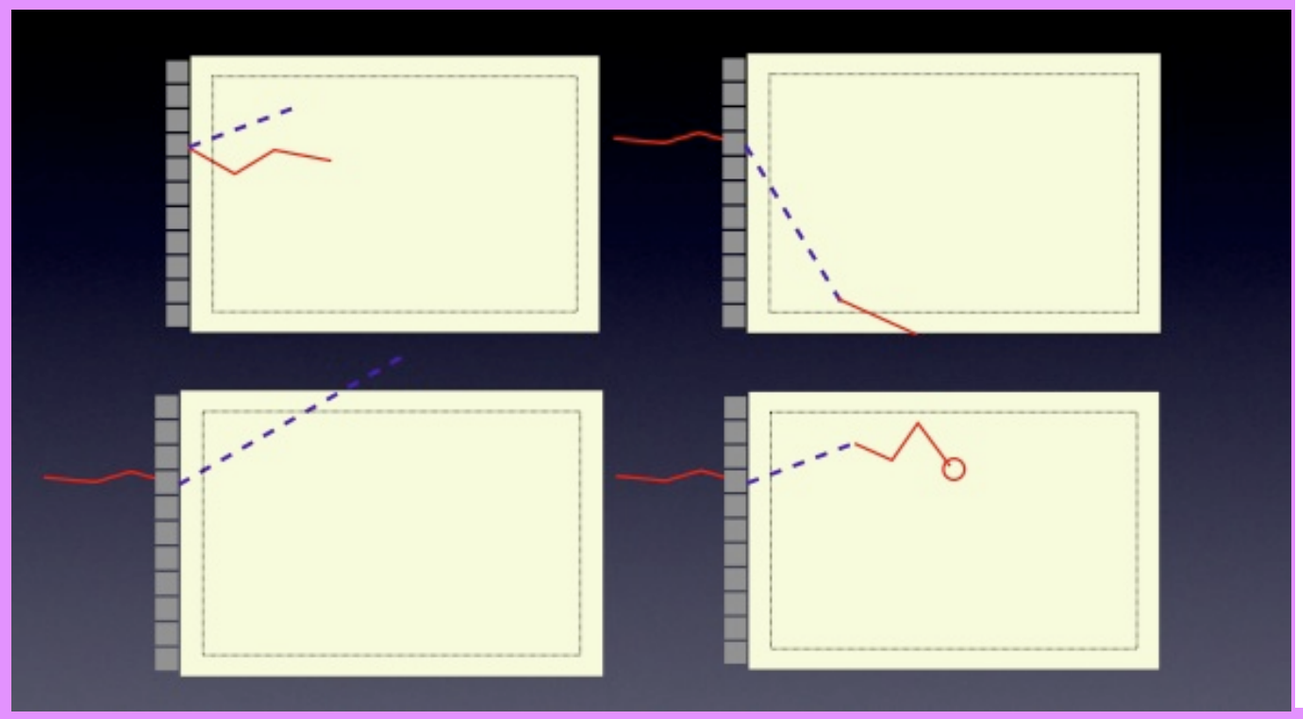


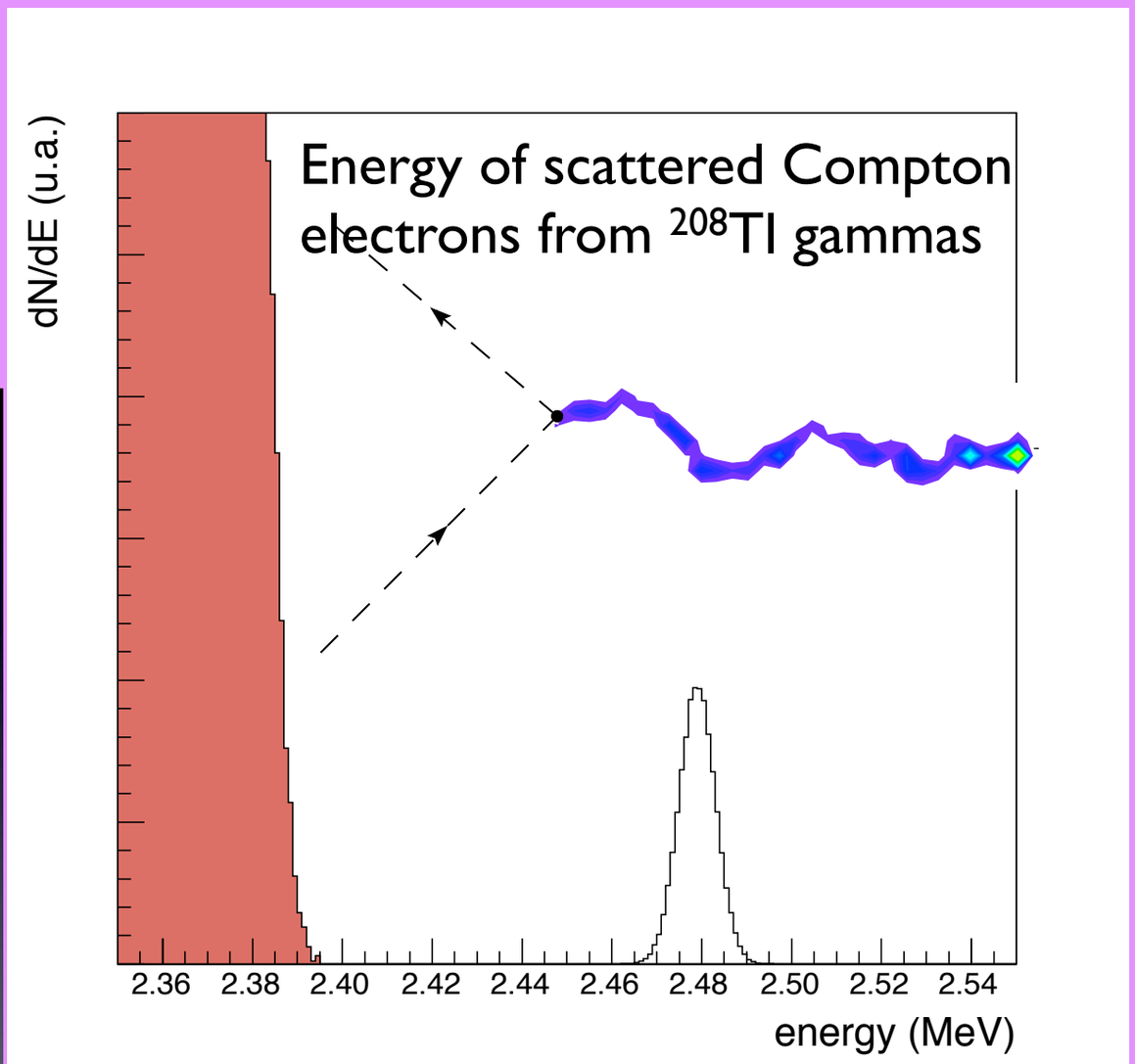


Background Considerations

Passive shielding will reduce external gamma and also neutron capture
Active shielding will eliminate most of the muon contribution

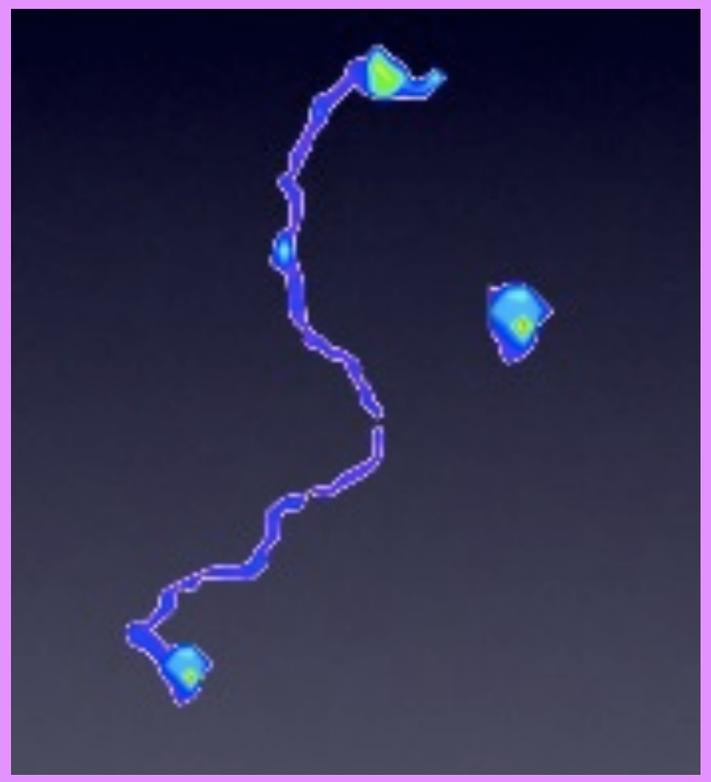
- γ(2449 keV) from ^{214}Bi decay (from ^{238}U and ^{222}Rn decay chain)
- γ(2615 keV) from ^{208}Tl decay (from ^{232}Th decay chain)





Geometrical rejection: Rejection factor 10^{-2} ($E_g > 2$ MeV)

Background Considerations

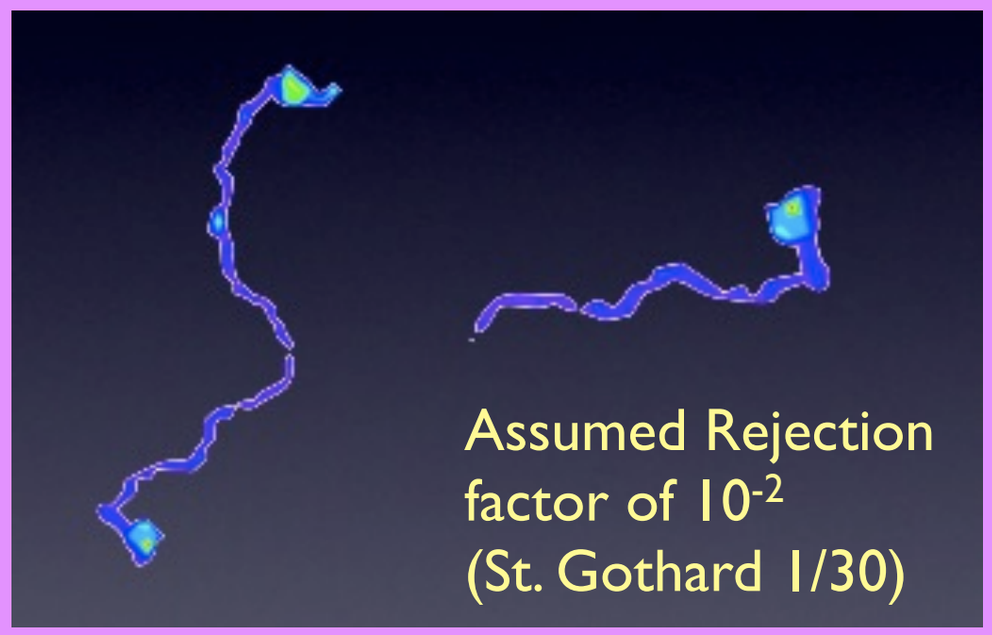


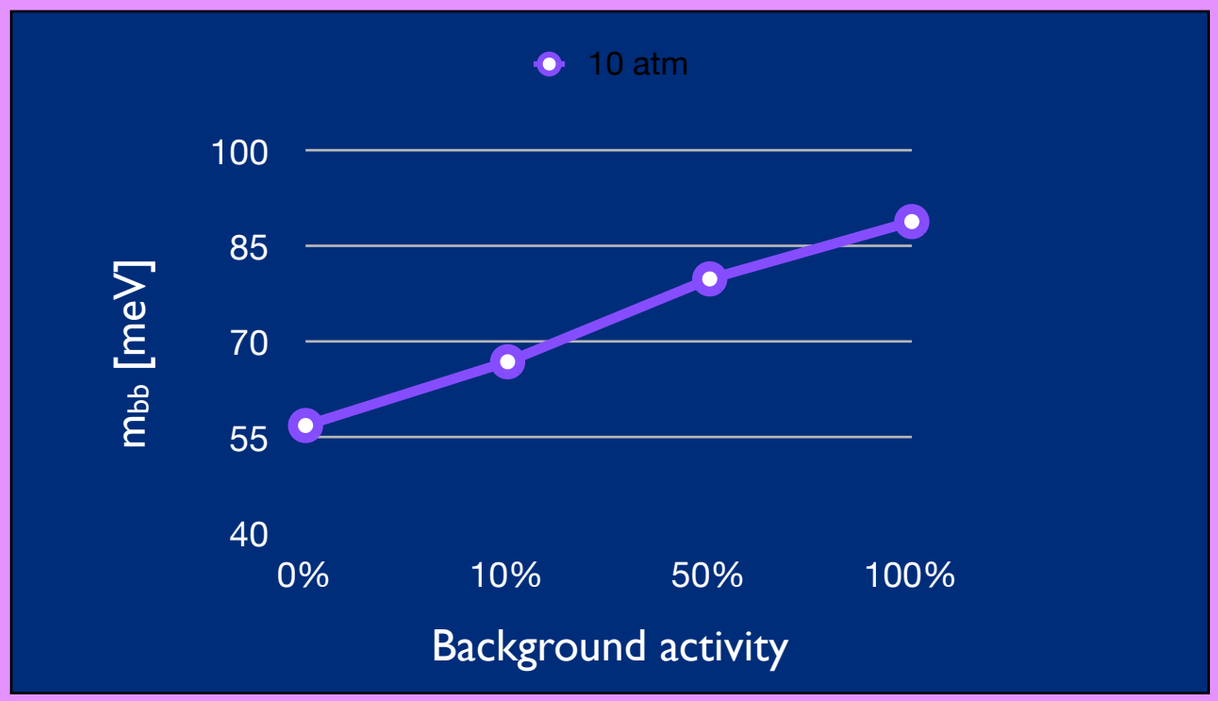
Event Topology with additional blob.
Rejection factor 10^{-1}

With energy window of 25 keV
Rejection factor 10^{-3}
⇒ Total rejection factor of 10^{-6}

Used Parameters:
- Chamber dimensions 1 x 1 x 2 m^3
- Energy resolution: 1 % FWHM
- Data taking of 5 years

Background from PMTs
- Size: 1"x1"
- Total number of PMTs: 40x40 = 1600
- Activity: 1.0 mBq/PMT





Conclusion

- Gaseous Xenon TPC seems to be a great opportunity for $\beta\beta^{0\nu}$ searches (and WIMPs ?)
- Funding is approved for five years by the spanish ministry of science.
- First official collaboration meeting was a fruitful kick of to the project (Bad News is: Now we really have to work !)
- Main sources of potential backgrounds are identified, simulation has to quantify the power of the Pattern Recognition - tool
- First Measurements of the MM are promising to fit the boundary conditions with a more sophisticated gas system and small contribution of quencher.
- First HP-TPC for EL measurements is commissioned right now in Barcelona.